

WHAT IS CLAIMED IS:

1. An image processing apparatus that carries out predetermined image processing of image data, which are to be displayed on an image display apparatus, and thereby generates supplied data to the image display apparatus,

the image display apparatus being a liquid crystal display apparatus that provides frame rate control-type tone display and has a less number of expressible display tones with regard to each pixel than a number of tones in the image data,

the image processing apparatus comprising:

an input unit that inputs the image data; and

a color reduction process unit that sets a display tone value, which is expressible by the liquid crystal display apparatus, with regard to each pixel, based on tone values of the image data,

wherein a range of the tone values allocated to each display tone value in at least either one of a high tone region and a low tone region by the color reduction process unit is narrower than that in an intermediate tone region.

2. An image processing apparatus in accordance with claim 1, wherein the color reduction process unit carries out a dispersion-type halftoning process.

3. An image processing apparatus in accordance with claim 1 further comprises an image data correction unit that carries out the correction that reduces a tone distribution in the intermediate tone region while enhancing tone distributions in both the low tone region and the high tone region.

4. An image processing apparatus in accordance with claim 1 further comprises:

storage means that stores therein a mapping of tone values of the input image data and corrected tone values, and

an image data correction unit that refers to the storage means and corrects the tone values.

5. An image processing apparatus that carries out predetermined image processing of image data, which are to be displayed on an image display apparatus, and thereby generates supplied data to the image display apparatus,

the image display apparatus having a less number of expressible display tones with regard to each pixel than a number of tones included in the image data, giving output lightness that varies stepwise against display tone value, and having a non-linear display characteristic that provides the output lightness at varying intervals,

the image processing apparatus comprising:

an image data correction unit that carries out tone correction by taking into account the non-linear display characteristic to enhance a tone distribution corresponding to an area of wide intervals, while reducing a tone distribution corresponding to an area of narrow intervals in a tone

distribution of input image data; and

a color reduction process unit that divides a range of the tone correction into a preset number of divisions and allocates tone corrected values in each division to each display tone value according to a predetermined rule, so as to implement color reduction.

6. An image processing apparatus in accordance with claim 5, wherein the preset number of divisions is obtained by dividing the range of the tone correction into substantially equal parts.

7. An image processing apparatus in accordance with claim 5, wherein the color reduction process unit carries out a dispersion-type halftoning process.

8. An image processing apparatus in accordance with claim 7, wherein the color reduction process unit carries out the dispersion-type halftoning process only when the image data is a specified type.

9. An image processing apparatus in accordance with claim 5, wherein the image display apparatus is a liquid crystal display apparatus applied for a cellular phone and implements frame rate control-type tone display.

10. An image processing apparatus that carries out predetermined image processing of image data, which are to be displayed on an image display apparatus, and thereby generates supplied data to the image display apparatus,

the image display apparatus having a less number of expressible display tones with regard to each pixel than a number of tones included in the image data, giving output lightness that varies stepwise against display tone value, and having a non-linear display characteristic that provides the output lightness at varying intervals,

the image processing apparatus comprising:

a color reduction process unit that divides a range of tone values of the image data into plural divisions of varying widths corresponding to the non-linear display characteristic and allocates tone values in each division to each display tone value according to a predetermined rule, so as to implement color reduction.

11. An image processing apparatus in accordance with claim 10, wherein the color reduction process unit carries out a dispersion-type halftoning process.

12. An image processing apparatus in accordance with claim 11, wherein the color reduction process unit carries out the dispersion-type halftoning process only when the image data is a specified type.

13. An image processing apparatus in accordance with claim 10, wherein the image display apparatus is a liquid crystal display apparatus

applied for a cellular phone and implements frame rate control-type
tonedisplay.

14. An image processing apparatus in accordance with claim 5,
wherein the image data correction unit carries out the tone correction that
reduces a tone distribution in an intermediate tone region while enhancing
tone distributions in both a low tone region and a high tone region.

15. An image processing apparatus in accordance with claim 5, the
image processing apparatus further comprising:
storage means that stores therein a mapping of tone values of the input
image data and corrected tone values,
the image correction unit refers to the storage means to correct the tone
values.

16. An image processing apparatus in accordance with claim 15, the
image processing apparatus comprising:

a plurality of the storage means are provided corresponding to a plurality of
settings for a predetermined condition, the predetermined condition affecting
the display characteristic of the image display apparatus; and

a storage means selection unit that selects one among the plurality of
storage means, based on an input setting for the predetermined condition.

17. An image processing apparatus in accordance with claim 16,
wherein the predetermined condition is temperature around the image
display apparatus.

18. An image processing apparatus in accordance with claim 16,
wherein the predetermined condition is brightness around the image display
apparatus.

19. An image processing apparatus in accordance with claim 16,
wherein the image display apparatus is a liquid crystal display apparatus
with a backlight, and the predetermined condition is brightness of the
backlight.

20. An image processing apparatus in accordance with claim 16,
wherein the predetermined condition is a setting of a contrast adjuster that
adjusts display contrast of the image display apparatus.

21. An image processing apparatus that carries out preset tone
correction of image data, which are to be displayed on an image display
apparatus,

the image display apparatus having a less number of expressible
display tones with regard to each pixel than a number of tones included in
the image data and giving output lightness that varies stepwise against
display tone value,

the image processing apparatus comprising:

a first storage unit that stores a plurality of characteristic curves

corresponding to a plurality of settings for a predetermined parameter, each characteristic curve representing a relationship between the tone value of the image data and the lightness;

a second storage unit that stores therein a preset characteristic curve that represents a desired relationship between the tone value and the lightness;

a data generation unit that receives an input of the predetermined parameter, selects a characteristic curve among the plurality of characteristic curves according to the input of the predetermined parameter, and generates data that represents a mapping of tone values of input image data and corrected tone values, based on the selected characteristic curve and the preset characteristic curve, so as to compensate for a difference between the selected characteristic curve and the preset characteristic curve; and

an image data correction unit that corrects tone values of the input image data by referring to the generated data.

22. An image processing apparatus that carries out predetermined image processing of image data, which are to be displayed on an image display apparatus, and thereby generates supplied data to the image display apparatus,

the image processing apparatus comprising:

storage means that stores in advance a relationship between tone values before and after tone correction, which is set based on a display characteristic of the image display apparatus;

an image data correction unit that carries out tone correction of the image data, based on the stored relationship; and

a color reduction process unit that carries out color reduction to convert tones of the corrected image data into tones expressible by the image display apparatus.

23. An image processing apparatus in accordance with claim 22, wherein the color reduction process unit carries out a dispersion-type halftoning process.

24. An image processing apparatus in accordance with claim 22, the image processing apparatus comprising:

a plurality of the storage means that are provided corresponding to a plurality of settings for a predetermined condition, the predetermined condition affecting the display characteristic of the image display apparatus; and

a storage means selection unit that selects one among the plurality of storage means, based on an input setting for the predetermined condition.

25. An image processing method that carries out predetermined image processing of image data, which are to be displayed on a liquid crystal display apparatus, and thereby generates data that are supplied to the liquid crystal display apparatus, the liquid crystal display apparatus providing frame rate control-type tone display and having a less number of expressible

display tones with regard to each pixel than a number of tones in the image data,

the image processing method comprising the steps of:

(a) specifying a display characteristic of the liquid crystal display apparatus of interest; and

(b) setting a display tone value, which is expressible by the liquid crystal display apparatus, with regard to each pixel, based on tone values of the image data, so that a range of the tone values allocated to each display tone value in at least either one of a high tone region and a low tone region is narrower than that in an intermediate tone region.

26. An image processing method that carries out predetermined image processing of image data, which are to be displayed on an image display apparatus, and thereby generates supplying data to the image display apparatus, the image display apparatus having a less number of expressible display tones with regard to each pixel than a number of tones included in the image data, giving output lightness that varies stepwise against display tone value, and having a non-linear display characteristic that provides the output lightness at varying intervals,

the image processing method comprising the steps of:

(a) specifying a display characteristic of the image display apparatus of interest;

(b) carrying out tone correction by taking into account the non-linear display characteristic to enhance a tone distribution corresponding to an area of wide intervals, while reducing a tone distribution corresponding to an area of narrow intervals in a tone distribution of input image data; and

(c) dividing a range of the tone correction into a preset number of divisions and allocating tone corrected values in each division to each display tone value according to a predetermined rule, so as to implement color reduction.

27. An image processing method that carries out predetermined image processing of image data, which are to be displayed on an image display apparatus, and thereby generates supplied data to the image display apparatus, the image display apparatus having a less number of expressible display tones with regard to each pixel than a number of tones included in the image data, giving output lightness that varies stepwise against display tone value, and having a non-linear display characteristic that provides the output lightness at varying intervals,

the image processing method comprising the steps of:

(a) specifying a display characteristic of the image display apparatus of interest;

(b) dividing a range of tone values of the image data into plural divisions of varying widths corresponding to the non-linear display characteristic and allocating tone values in each division to each display tone value according to a predetermined rule, so as to implement color reduction.

28. A method of generating data that are used for predetermined tone

correction of image data, which are to be displayed on an image display apparatus, the image display apparatus having a less number of expressible display tones with regard to each pixel than a number of tones included in the image data and giving output lightness that varies stepwise against display tone value,

the data generating method comprising the steps of:

(a) specifying a characteristic curve that represents a current relationship between the tone value of the image data and the lightness;

(b) presetting a characteristic curve that represents a desired relationship between the tone value and the lightness; and

(c) generating data that represents a mapping of tone values of input image data to corrected tone values, based on the characteristic curve specified in the step (a) and the characteristic curve preset in the step (b), so as to compensate for a difference between the specified characteristic curve and the preset characteristic curve.

29. An image processing method that carries out predetermined image processing of image data, which are to be displayed on an image display apparatus, and thereby generates supplied data to the image display apparatus,

the image processing method comprising the steps of:

storing in advance a relationship between tone values before and after tone correction, which is set based on a display characteristic of the image display apparatus,

carrying out tone correction of the image data, based on the stored relationship; and

carrying out color reduction to convert tones of the corrected image data into tones expressible by the image display apparatus.

30. A computer program product that comprises a computer program carrying out predetermined image processing of image data, which are to be displayed on a liquid crystal display apparatus, the liquid crystal display apparatus providing frame rate control-type tone display and having a less number of expressible display tones with regard to each pixel than a number of tones in the image data,

the computer program causing a computer to attain the functions of:

specifying a display characteristic of the liquid crystal display apparatus of interest; and

setting a display tone value, which is expressible by the liquid crystal display apparatus, with regard to each pixel, based on tone values of the image data, so that a range of the tone values allocated to each display tone value in at least either one of a high tone region and a low tone region is narrower than that in an intermediate tone region.

31. A computer program product that comprises a computer program carrying out predetermined image processing of image data, which are to be displayed on an image display apparatus, the image display apparatus having a less number of expressible display tones with regard to each pixel than a number of tones included in the image data, giving output lightness

that varies stepwise against display tone value, and having a non-linear display characteristic that provides the output lightness at varying intervals, the computer program causing a computer to attain the functions of: specifying a display characteristic of the image display apparatus of interest; carrying out tone correction by taking into account the non-linear display characteristic to enhance a tone distribution corresponding to an area of wide intervals, while reducing a tone distribution corresponding to an area of narrow intervals in a tone distribution of input image data; and dividing a range of the tone correction into a preset number of divisions and allocating tone corrected values in each division to each display tone value according to a predetermined rule, so as to implement color reduction.

32. A computer program product that comprises a computer program carrying out predetermined image processing of image data, which are to be displayed on an image display apparatus, the image display apparatus having a less number of expressible display tones with regard to each pixel than a number of tones included in the image data, giving output lightness that varies stepwise against display tone value, and having a non-linear display characteristic that provides the output lightness at varying intervals, the computer program causing a computer to attain the functions of: specifying a display characteristic of the image display apparatus of interest; dividing a range of tone values of the image data into plural divisions of varying widths corresponding to the non-linear display characteristic and allocating tone values in each division to each display tone value according to a predetermined rule, so as to implement color reduction.

33. A computer program product that comprises a computer program generating data used for predetermined tone correction of image data, which are to be displayed on an image display apparatus, the image display apparatus having a less number of expressible display tones with regard to each pixel than a number of tones included in the image data, giving output lightness that varies stepwise against display tone value, and having a non-linear display characteristic that provides the output lightness at varying intervals, the computer program causing a computer to attain the functions of: specifying a characteristic curve that represents a current relationship between the tone value of the image data and the lightness; presetting a characteristic curve that represents a desired relationship between the tone value and the lightness; and generating data that represents a mapping of tone values of the image data to corrected tone values, based on the specified characteristic curve and the preset characteristic curve, so as to compensate for a difference between the specified characteristic curve and the preset characteristic curve.

34. A recording medium in which a computer program is recorded in a computer readable manner, the computer program carrying out predetermined image processing of image data, which are to be displayed on

an image display apparatus, the image display apparatus having a less number of expressible display tones with regard to each pixel than a number of tones included in the image data, giving output lightness that varies stepwise against display tone value, and having a non-linear display characteristic that provides the output lightness at varying intervals,

the recording medium including data that are recorded therein to represent a mapping of tone values of image data input into the image processing apparatus to corrected tone values, as data applied for the image processing.